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ABSTRACT

The document, part of a series of chapters described in SO 011 759, presents an overview of theories about the labor market structure, suggests hypotheses about patterns of job shifts, and describes methods and results of testing these hypotheses. Three sections comprise the document. Section I defines basic labor market terms. Section II considers alternative explanations of the dependence of job-shift patterns on labor market structure and reviews literature concerning flexible and inflexible employment conditions. Flexible conditions occur when an employer can readily adjust an employer's wage up or down and either employer or employee can terminate the match at any time, whereas inflexible conditions assume that employers cannot readily adjust an employer's wage or terminate employment. In this section the author also proposes a new model for analyzing job shift patterns. Section III discusses a study of job shift patterns for full time jobs of civilian nonagricultural male workers in the labor force in 1968. Job rewards (wages and prestige) and personal resources (education and ability) were the basic variables. Results indicate that the proportion of job shifts accompanied by gains in prestige and wages exceeds those accompanied by losses. The finding is consistent with the argument that employment tends to be more inflexible in large firms than in small ones, assuming that most intrafirm moves originate in large firms. Also, the effect of education on upward moves is greater for interfirm moves than for intrafirm moves. Finally, the results indicate that determinants of a job shift rate depend on a person's social location and not just on his characteristics. (Author/KC)

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PART III -- Chapter 7

Final Report for

DYNAMIC MODELS FOR CAUSAL ANALYSIS OF PANEL DATA

EFFECTS OF LABOR MARKET STRUCTURE ON JOB-SHIFT PATTERNS

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EFFECTS OF LABOR MARKET STRUCTURE ON JOB-SHIFT PATTERNS

A recurring theme in the literature on labor market structure is that different labor markets are characterized by different patterns of job mobility. For example, Doeringer and Piore (1971, p. 40) regard stability of employment as "the most salient feature of the internal labor market." Kerr (1954, pp. 95-96) contrasts "structureless" markets that lack "barriers to the mobility of workers" with institutional markets in which entrance, movement and exit are constrained by rules. Spilerman (1977) emphasizes career lines, noting how these may depend not only on personal characteristics but also on the occupation, industry and firm of a person's port of entry.

Not everyone agrees that job-shift patterns reflect differences in labor market structure. Some attribute these differences to various labor market imperfections: uncertainty (Becker et al., 1977), search costs (Oi, 1962), specific investments (Becker, 1964), and so forth. Others (e.g., Heckman and Willis, 1977; Doeringer and Piore, 1971, pp. 175-176) associate differences in job-shift patterns with differences in workers: in nonmarket productivity, in preferences for leisure versus money and prestige, and so forth. Even those who attribute these differences to differences in labor market structure do not agree on the boundaries of labor markets or on the reasons why occupants of certain kinds of jobs have similar job-shift patterns.

Resolution of these disagreements requires an explanation of the forms of labor market structure and of the consequences of these forms for job-shift patterns. In turn, verbal explanations require translation into testable models. It also requires data that allow competing explanations to be tested and a method for organizing the data so that consequences of competing

arguments can confront one another.

This paper is organized as follows. I begin by defining several basic terms in Section I. In Section II I review several explanations of the dependence of job-shift patterns on labor market structure and suggest hypotheses about job shifts congruent with these explanations. In Section III I describe the methods used in testing these hypotheses. The data come from retrospective life histories of a national sample of white males age 30-39 years old in 1968. I specify the hypotheses in terms of models of the instantaneous rate of a shift among jobs. Following suggestions of several previous authors (e.g., Coleman, 1964; Spilerman, 1972a; Tuma, 1976), I allow the rate of a shift to depend on observed characteristics of people and jobs. The explanations reviewed in Section II yield hypotheses about effects on the shift rate. I also propose a variant of each model that incorporates random variation in the rate of a job shift due to pure noise and unobservable characteristics of people and jobs. This proposal extends suggestions of various authors (e.g., Silcock, 1954; Blumen et al., 1955; Spilerman, 1972b) that unobserved heterogeneity affects mobility rates. I estimate parameters in the models by the method of maximum likelihood. Section IV reports the results.

I. BASIC TERMS

Labor Market

Consider a system with uncoerced exchanges between three kinds of parties: employees (A), employers (B), and consumers (C). Suppose A performs tasks for B in return for money, B exchanges the products of A's labor with C for money, and A and C do not exchange directly with one another. Then "labor market" refers to the first set of exchanges, while "product market" refers to the second set. Note that "labor market" does not

include those who consume what they produce (e.g., peasants), those who are not paid for their labor (e.g., slaves, prisoners, volunteers), and those who exchange their labor directly with consumers (e.g., those who are self-employed).

Labor Market Structure

It is more difficult to define "labor market structure" because of variability in its usage.[1] This variability, more than disagreements about actual empirical relationships, seems to be a major source of arguments about whether the United States has a single labor market, dual markets, or multiple (segmented) markets. An accurate tally probably has little value. However, an important issue underlies these debates: Is there a single mechanism by which people are allocated to jobs, and rewards distributed among them in return? Or, are there several different mechanisms? If there are several, what are they, and how and why do they arise? As used in this paper, the term "labor market structure" refers to this set of issues.

Job-Shift Patterns

As mentioned in the introduction, Doeringer and Piore (1971) focus on "stability of employment." Kerr (1954) is concerned with "barriers to mobility." Spilerman (1977) emphasizes "career lines"--the relative frequency of holding different kinds of jobs in a certain sequence. All of these are important aspects of job-shift patterns. The construct upon which models of job shifts are based should have implications for each aspect.

A construct with these properties can be defined as follows. Let $Y(t)$ denote the characteristics of a job held by a representative person at time t. Define $G_j(t|u)$ as follows:

$$G_j(t|u) = \Pr[Y(t)=j;Y(v_n)=j; \ . \ . \ ;Y(v_1)=j|Y(u)=j] \qquad (1)$$

for all j and $u \leq v_1 \leq \cdots \leq v_n \leq t$, for any positive n. Note that $G_j(t|u)$, which is usually called the survivor function for j, equals 1 when t=u and cannot increase as (t-u) increases. Then define the (instantaneous) rate of leaving j as:

$$r_j(t|u) = \lim_{\Delta t \to 0^+} \frac{[G_j(t|u) - G_j(t+\Delta t|u)]}{G_j(t|u)\Delta t} \qquad (2)$$

The term in brackets in (2) cannot be negative because $G_j(t|u)$ cannot increase as t increases. Both terms of the denominator are also nonnegative. Consequently, the rate of leaving j is nonnegative. In theory it can take any positive value; I assume that it is always finite.

Next define $m_{jk}(t|u)$ as the conditional probability of a transition from j to k at time t, given j is occupied continuously from time u to time t:

$$m_{jk}(t|u) = \lim_{\Delta t \to 0^+} \Pr[Y(t+\Delta t)=k|Y(t)=j;Y(v_n)=j; \ . \ . \ ;Y(v_1)=j;Y(u)=j] \qquad (3)$$

Finally define

$$r_{jk}(t|u) = r_j(t|u)\, m_{jk}(t|u) \qquad (4)$$

I refer to $r_{jk}(t|u)$ as the (instantaneous) rate of a shift from job j to job k at time t, conditional on occupying j at time u. In subsequent discussion I sometimes refer to a transition from j to k in terms of a shift from origin j to destination k. "Origin j" refers to the job left, while "destination k" denotes the state entered.

Stability of employment in job j implies that the rate of leaving job j, $r_j(t|u)$, is very low. Barriers to mobility between two kinds of jobs j and k connotes that either $m_{jk}(t|u)$ is very low or possibly that employment in job j is very stable. Thus, barriers to mobility imply that the rate of a shift from j to k, $r_{jk}(t|u)$, is very small. The career lines that Spilerman (1977) discusses can also be described in terms of transition rates; however, the description may require that these rates depend on jobs held before j.

II. ALTERNATIVE EXPLANATIONS

A basic premise of traditional microeconomic theory of the labor market is that the main conditions surrounding a job-person match are flexible. In particular, an employer can readily adjust an employee's wage rate up or down if he wishes, and either employer or employee can terminate the match at any time. Flexible employment refers to jobs with these conditions.

Recently some economists and sociologists (e.g., Thurow, 1975; Sorensen, 1977a; Sorensen and Kalleberg, 1977) have claimed that in many sectors of the U.S. economy the conditions of job-person matches are inflexible. That is, they assert that employers cannot readily adjust an employee's wage rate (especially down) and that the right to terminate job-person matches has been relinquished by employers, though not by employees.[2]

Proponents of each view must explain why a given condition of employment arises. They must also explain how the postulated type of employment accounts for three well-documented empirical generalizations: (1) a positive cross-sectional correlation between job rewards (e.g, the wage rate, occupational prestige) and personal resources (e.g., education, ability);

(2) an increase in job rewards over a person's life cycle; (3) greater employment stability of persons holding jobs with greater rewards.[3]

In this paper I make only passing remarks about the implications of each type of employment for the first and second generalizations, and I attend only briefly to arguments about why employment is flexible or inflexible. Instead I concentrate on implications of selected explanations postulating each type of employment for employment stability and other features of job-shift patterns. I propose testable hypotheses congruent with each explanation.

Flexible Employment

Perfect Competition. Because of its simplicity and theoretical centrality, I begin with the explanation based on the assumption that there is a single, perfectly competitive market for labor. A number of premises, in addition to flexible employment, underlie this explanation. One is that goods exchanged in the market are homogeneous: people are equally productive, and jobs are equally attractive as long as they pay the same wage. A second is that buyers and sellers have perfect information about the goods and prices offered in the market: no one is uncertain about the outcome of any possible exchange. A third is that the market contains many buyers and sellers: singly no one can determine prices.[4]

When employment is flexible, these postulates imply that there is a single price for labor (i.e., a single wage rate) in a short-run equilibrium. The first empirical generalization mentioned above contradicts this, as Adam Smith and other early economists recognized. However, if we alter the first premise to assume that workers vary in productivity (according to their education, strength, etc.) and that jobs vary in nonpecuniary ways

(in prestige, working conditions, etc.), the explanation predicts a cross-sectional covariation between job rewards and personal resources in equilibrium. The modified explanation is usually termed marginal productivity theory because it predicts that each laborer's marginal utility equals his marginal product.

As this explanation stands, it cannot explain the second empirical generalization mentioned above: the typical rise in job rewards over the life cycle. But the second can be explained by human capital theory, which argues that workers invest in their resources (productive capacity) as long as these investments yield a positive expected return. Human capital theory predicts that workers invest heavily in training (some formal and some on-the-job) when they are young and reap the benefits in the form of increased wages as they become older. Furthermore, those who invest heavily in their resources during youth have age-earnings curves that rise more steeply than the curves of those whose investments are smaller.

But what are the implications of this theory for job shifts? In equilibrium job shifts do not occur because no one can improve upon his present situation. Thus the occurrence of a job shift implies that either the employer or the employee is not in equilibrium. Marginal productivity theory suggests a list of exogenous changes causing disequilibrium, but it does not explain why disequilibrating changes occur, or how frequently. Out of ignorance we can only hypothesize that these disequilibrating events, and the jobs shifts generated by them, occur at a random rate α that does not depend on characteristics of jobs or jobholders (see Sorensen and Tuma, 1978).

Imperfect Competition. In recent decades various "imperfections" have been postulated so that the competitive model will predict differential stability that accords with the third empirical generalization mentioned earlier. I focus on the recent work of Becker, Landes and Michael (1977), hereafter referred to as BLM, because it epitomizes the best work along these lines. However, the arguments of BLM are directed toward an explanation of marital stability, and they make only tangential remarks about job stability. So I have had to translate their arguments about one process into arguments about another. Statements below about BLM's argument should be read as my interpretation of their argument; their own translation might differ from mine.

BLM's key assumption is the absence of perfect information. Employers must use observable indicators of a person's resources to select employees (see also Spence, 1974), while workers must use observable indicators of a job's rewards to select jobs. Partly because of unobservable variables and partly because of search costs, some mismatches occur, even in equilibrium. A shift occurs when a mismatch is discovered and can be resolved in favor of their mutual gain. This conclusion is important because exogenous changes need not be invoked to explain mobility.

BLM also consider the determinants of stability. Their argument has several components. I concentrate on aspects suggesting effects of rewards and resources on job shifts.[5] They reason that stability increases with the expected gains from a match and decreases with unexpected gains (the discrepancy between actual and expected gains), assuming expected and unexpected gains do not have a strong negative correlation. Expected gains increase with the value of variables describing traits positively associated in an

optimal sorting of all potential exchange partners in the system (Becker, 1974). Since the skill level of a job and a person's education are complementary traits, they should be positively associated in an optimal sorting. Consequently, employment stability should increase with personal resources and job rewards, assuming job rewards partly reflect the job's skill level. This leads to the hypothesis that the rate of leaving a job falls as job rewards and personal resources rise. Thus the assumption of competition with imperfect information predicts the third empirical generalization.

Although BLM explain differential stability, they have little to say about the level of rewards in successive matches, perhaps because they are discussing marriages. But the implications of flexible employment for the difference in rewards of the jobs entered and left (hereafter called the change in rewards) are clear: the expected change is zero. Rewards rise if resources rise, but this happens within a job. It is not necessary to change jobs to obtain rewards commensurate wtih one's resources. If the change in rewards is divided into three categories (a gain, a loss, and no change), gains and losses are equally likely. This suggests the hypothesis that the rate of a move with a gain (an upward move) equals the rate of a move with a loss (a downward move). The rate of a move with no change in rewards (a lateral move) may differ from these because of special conditions of the job.[6] The hypothesis that the rates of upward and downward moves are equal provides an alternative representation of the picture of mobility under perfect competition.

It is also possible to tease out of BLM's arguments implications for the rates of upward, downward, and lateral moves. Let D represent the difference between the initial rewards in a job and those expected on the

basis of personal resources. Following BLM's reasoning, imperfect information predicts that D has a random distribution with a mean of zero. For positive D, the employee is initially overrewarded; for negative D, underrewarded. Downward moves should be more likely when D is positive, while the opposite should hold when D is negative. But D is an increasing function of observable job rewards and a decreasing function of observable resources of the employee. So the rate of a downward move should increase with job rewards and decrease with personal resources, while the rate of an upward move should decrease with job rewards and increase with personal resources. The rate of lateral moves should be unrelated to rewards and resources. A hint of this argument, similar to one proposed by Tuma (1976), can be found in BLM's paper (1977, p. 1145).

Inflexible Employment

Under conditions of inflexible employment, wages do not adjust to the productivity of jobholders, at least in the short run. Because of this employers have a strong incentive to hire the "best" people--those with the most personal resources. Similarly, employees have a strong incentive to accept the "best" jobs--those with the greatest rewards. So explanations assuming inflexible employment also predict a positive correlation between rewards and resources in a cross-section.

When employment is inflexible, an employee leaves a job only under his own volition when he obtains access to a better job. Thus the expected gain from a job shift is positive. Moreover, mobility becomes the fundamental mechanism for people to increase job rewards. Average rewards rise over the life cycle for people who shift jobs, but not for those who do not move. Thus the assumption of inflexible employment also predicts the

second empirical generalization.

Job Competition. Thurow's (1975) arguments for job competition implicitly assume that employment conditions are inflexible. In addition, he assumes that jobs with the highest rewards require the most skills and training. He argues that people are allocated to jobs with different training requirements on the basis of personal resources that serve as indicators of trainability, and not of existing productivity. Jobs are training slots.

Thurow is mainly concerned with showing that job competition predicts a positive correlation between rewards and resources and a rise in rewards over the life cycle. He gives little attention to its implications for job-shift patterns. However, it is clear from his arguments that the expected gain in rewards from shifting jobs is positive, i.e., that the rate of upward moves should greatly exceed the rate of downward moves.

His arguments are consistent with more than one pattern of effects of rewards and resources on the rate of job shifts. According to one interpretation, personal resources both increase with time in the labor force and depend on the kind of jobs held. His remarks suggest that the increase in resources from on-the-job training rise with the skill level of the job, as indicated by its rewards. As a person's resources and training increase, he becomes more likely to move to a job with more rewards, i.e., one providing more training. If this interpretation is valid, it leads to the hypothesis that the rate of an upward move increases with initial resources such as education, time in the labor force (an indicator of the length of on-the-job training), and job rewards (an indicator of the level of skills acquired in on-the-job training). Note that this hypothesis implies that the effects of rewards and resources are exactly opposite those predicted

by imperfect competition. The rich (those in highly rewarded jobs) are those most likely to get richer (promoted to more highly rewarded jobs).

Vacancy Competition. It is not completely clear from Thurow's remarks whether he claims that acquired resources (as indicated by job rewards and time in the labor force) influence employers' selection of persons to fill jobs. Sørensen (1977a) explicitly assumes they do not, i.e., that resources are fixed over a person's career. He contends that people compete for vacancies in jobs with the highest rewards and has given the name "vacancy competition" to his argument.

In his model people entering the labor market are distributed randomly among jobs according to their level of resources. Rewards of the first job are lower than expected on the basis of a person's resources, but are positively correlated with them. Access to better jobs depends on the rewards of the current job, fixed resources, and the rate at which vacancies occur in jobs with higher rewards. Sørensen shows that his assumptions imply that average job rewards increase with time in the labor force and that the rate of mobility falls as time in the labor force increases. Both relationships reflect a decreasing gap between actual and expected rewards as time in the labor force increases, and not an increase in personal resources, as posited by human capital theory. If fixed resources and current rewards are controlled, time in the labor force should be unrelated to the rate of a job shift.

Like Thurow's argument, Sørensen's implies that the rate of a downward moves is almost zero. In addition, it implies that the rate of an upward move increases with resources, decreases with rewards, and is unaffected by time in the labor force, ceteris paribus. Note that the pattern of effects

for upward moves is the same as that implied by BLM's argument, with the possible exception of the effect of time in the labor force. The arguments mainly differ in their predictions about the rate of downward moves.

Where Is Employment Flexible and Inflexible?

Most proponents of marginal productivity theory assume that this theory applies equally well to all people and jobs in the United States. On the other hand, the literature on dual and segmented labor markets claims that the explanation of labor allocation and reward distribution varies. A fully elaborated theory of why one explanation applies to some jobs but not others is beyond the scope of this paper. It also could not be tested with the available data, described in Section III below, which provide fairly extensive information on attributes of persons but only rudimentary information on their jobs. Consequently, I concentrate on identifying situations in which different explanations might apply and for which these data contain indicators.

The reasons given by Thurow (1975) and by Sørensen and Kalleberg (1977) for the development of inflexible employment conditions suggest that these conditions tend to occur in large firms with a complex division of labor. In such firms, production often depends on the smooth and synchronous meshing of many people's skills, personalities and actions. These interdependencies make it costly to supervise and difficult to evaluate any one individual's contribution to the firm's product. They also increase the chance that successful work performance requires knowledge specific to the work setting.

Because it is difficult to supervise and evaluate the work performance of an individual, employers develop job ladders--jobs with increasing rewards linked by a promotion schedule--to motivate workers to perform at their capacity. Adjusting one person's wages in this system because of his

exceptional performance (even if recognized) threatens the system of incentives, whereas promoting him shows that merit is rewarded. So wages become inflexible and linked to jobs rather than to individual productivity.

Wage rigidity is only one aspect of employment inflexibility. The other is control over the termination of a job. Thurow (1975, pp. 81-84) argues that employers relinquish control over termination of employment so that coworkers will assent to training and sharing specific knowledge with coworkers. As mentioned above, firm-specific knowledge should increase with a firm's size, other things being equal. In addition, medium and large firms are much more likely than small ones to be the target of unionization, which has traditionally limited the employer's ability to terminate any particular job-person match, except for an initial brief probationary period and for carefully circumscribed causes.[7]

The overall opportunities for an employer to retain control over the conditions of employment for a single job-person match seem much greater in small firms than in large ones. First, with few employees to train and supervise, the owner/manager may not need to delegate these tasks to an employee's coworkers. Furthermore, both successes and mistakes may be more visible and easily tagged to one person in a small firm than in a large one.[8] Moreover, there are simply not enough jobs in a small firm to create a job ladder to motivate performance of employees, even if the employer should want to do this. Consequently, the employer in a small firm is more likely to rely on immediate rewards like raises and bonuses. Finally, in a small firm there may be very few people with similar jobs so that the wages of one person can be adjusted to his marginal productivity without other employees feeling that this affects their own opportunities.

The discussion above contends that conditions of employment tend to be flexible in small firms and inflexible in large firms. Consequently, patterns of job shifts in small firms should resemble those predicted by perfect or imperfect competition, while patterns of job shifts in large firms should resemble those predicted by job or vacancy competition. The available data lack information on firm size, but do record whether a job shift involves a change of employer. Moves within a firm should mainly occur in large firms simply because a small firm has many fewer jobs that can become vacant. So moves originating in a small firm will tend to be moves out of the firm. Of course, some moves out of a firm originate in large firms too. Nevertheless, there should be an association between firm size and type of move. This supplementary assumption leads to the hypothesis that patterns of job shifts within a firm should resemble those predicted by job or vacancy competition and that patterns of job shifts out of a firm should more nearly resemble those predicted by perfect or imperfect competition.[9]

Reflection on labor allocation for employers hiring from within and from without their existing work force suggests several subsidiary hypotheses. When a firm hires an outsider, it must rely heavily on a few stock indicators of trainability and performance, for example, education, race, and sex. These may be screening devices (Spence, 1974), but poor ones. When a firm promotes an insider, it can not only use these stock indicators but also assess the person's performance in a similar (if less skilled) job.[10] This reasoning suggests the following hypotheses: (1) The effect of education on the rate of an upward move is smaller for moves within a firm than for moves out of a firm. (2) The effect of an ability measure on the rate of an upward

move is larger for moves within a firm than for moves out of a firm. (3) Easily observed characteristics of persons and jobs (e.g., education, wage rate, etc.) explain the rate of upward moves out of a firm more than the rate of upward moves in a firm.

III. RESEARCH METHODS

Data

The data used in the analysis are life histories collected by James S. Coleman and Peter H. Rossi in order to study the educational, familial, residential and work experiences of U. S. men (see Blum et al., 1969). The universe is the total population of 30-39 year-old males who resided in the U.S. in 1968. There were two samples: a national sample and a supplementary sample of blacks. Interviews were conducted in January of 1969 and completed for a total of 1589 men (822 whites, 738 blacks, and 29 others). The rate of interview completion was 76.1% for the national sample and 78.2% for the supplementary sample.

The analyses reported below used data only on full-time jobs of white men. A comparison of job-shift patterns of white and black men would be of widespread interest but is not attempted here. Because the arguments discussed earlier pertain to shifts from jobs in which a person works as an uncoerced wage-laborer, I excluded data on periods of self-employment and military service. I also eliminated data on jobs in agriculture because both the wage rate and prestige of agricultural and nonagricultural jobs are probably incommensurate. Finally, I dropped the data when information was missing on variables (see Table 1) needed to estimate the models considered in this paper. With these selection

criteria, data on 4008 jobs of 716 different men were included in the analysis.

The basic explanatory variables discussed in Section II are job rewards and personal resources. Table 1 gives definitions and simple descriptive statistics for the measures of rewards and resources used in this paper.

One measure of job rewards is the wage rate (in dollars per hour). This is, of course, the indicator preferred by most economists. Another measure of a job's rewards is its occupational prestige. Prestige reflects many nonpecuniary values associated with an occupation, as well as monetary value (Goldthorpe and Hope, 1972). Not surprisingly, the wage rate and prestige of jobs held by whites are moderately correlated (0.38).

The primary measures of personal resources are education (years of completed schooling) and a score on 10-item test of verbal ability. The correlation between these variables is 0.33 for whites in these data.

Time in the labor force is also included. Economists often call this variable "labor force experience" under the assumption that it measures general skills acquired through working (see, for example, Mincer, 1974). But even if a person works almost continuously, time in the labor force is an imperfect measure of acquired work experience. It may partially indicate the discrepancy between a person's current job rewards and the rewards that he expects given his personal resources (Tuma, 1976). This is especially likely if employees largely control the timing of their job shifts (Sørensen, 1977a). There is some evidence supporting this interpretation: the effect of time in the labor force on the rate of a job shift is greatly diminshed when measures of job rewards and personal

resources are included in the analysis (Sørensen and Tuma, 1978).

Further complications arise because age and time in the labor force have a very high positive correlation (0.91 in these data). In addition, in these data the sample design forces a high positive correlation between the historical period and time in the labor force. Consequently, age and historical period could not be controlled in these analyses. So the effects of time in the labor force on the rate of a job shift may partly reflect effects of age and period. Even though other measures of resources are included in the analysis, effects of time in the labor force must be interpreted cautiously.

As indicated in the discussion of estimation below, the main "dependent" variables are the completed duration in a job and the kind of job shift that occurs. Completed duration in a job is just the difference between the beginning and ending dates of a job. Completed duration is not known for jobs held by respondents at the interview; however, the method of estimation used in the analysis allows information on these jobs to be used. However, it is necessary to distinguish between jobs that are left before the interview and those that are not.

Some explanations considered earlier imply that the effects of job rewards and personal resources depend on the kind of job shift that occurs. I argued that the effects of rewards and resources on the shift rate depend on the difference between rewards in the job entered and those in the job left. I also argued that the mechanisms determining shift rates differ in large and small firms.

Table 1 also defines the variable used to describe the kind of move. Note that changes in occupational prestige and in the wage rate are distinguished, and that "no change in the wage rate" is treated as a reported

change smaller than 5%. Because the wage rate is nearly a continuous variable, zero changes were very infrequent. It seemed reasonable to distinguish between large gains (and losses) in the wage rate and those so small that they could result from reporting error. The choice of 5% is arbitrary, of course; there would be slightly different results for a different choice.

As mentioned earlier, the data lack information on firm size, but do indicate whether a job shift involves a change of employers. Intrafirm shifts should occur mainly in large firms because a small firm contains few jobs that an employee can enter. Consequently, in the empirical analysis I distinguish between intra- and interfirm moves, assuming that the former originate in large firms. Moves originating in a small firms are assumed to be primarily interfirm moves; of course, interfirm moves may also originate in large firms.

Forms of Models Estimated

The arguments in Section II suggest that the rate of a shift from job j to job k for some individual i may depend on attributes of i, j and k, but does not depend on time:[21]

$$r_{ijk}(t|u) = r_{ijk} \qquad (5)$$

The different explanations considered in Section II generate different hypotheses about the direction of effects of variables on transition rates, but not the specific form of the relationship. I consider two forms. In Form A (discussed at some length in Tuma et al., in press), I assume that the rate r_{ijk} is a multiplicative function of attributes of i, j and k:

$$r_{ijk} = \alpha_{jk0}(\alpha_{jkX})^{X_i}(\alpha_{jkY})^{Y_j}(\alpha_{jkT})^{T_{ij}} \qquad (6)$$

where the α_{jk}'s are positive constants to be estimated, and the values of personal resources X_i, job rewards Y_j, and time in the labor force at the start of job j T_{ij} vary across job-person matches. In Form B, I assume that the transition rate is a product of two terms: one identical to the right-hand side of (6) and the other a gamma-distributed random disturbance with a mean of 1 and a variance σ^2:

$$r_{ijk} = [\alpha_{jk0}(\alpha_{jkX})^{X_i}(\alpha_{jkY})^{Y_j}(\alpha_{jkT})^{T_{ij}}]\varepsilon_{ijk} \qquad (7)$$

Table 2 gives Form A of the different models estimated. Below I comment briefly on each of the two forms.

Form A. Equation (6) can also be written as:

$$r_{ijk} = e^{\gamma_{jk0} + \gamma_{jkX}X_i + \gamma_{jkY}Y_j + \gamma_{jkT}T_{ij}} \qquad (8)$$

where the γ_{jk}'s in (8) are the natural logarithms of the α_{jk}'s in (6). Equation (8) implies that the conditional probability of a transition to k from j, m_{jk}, has a logit distribution, i.e., that the log of the odds of entering destination k rather than destination h is a linear function of X_i, Y_j, and T_{ij} (and implicitly also of Y_k and Y_h):

$$\ln m_{jk}/m_{jh} = (\gamma_{jk0}-\gamma_{jh0})+(\gamma_{jkX}-\gamma_{jhX})X_i+(\gamma_{jkY}-\gamma_{jhY})Y_j+(\gamma_{jkT}-\gamma_{jhT})T_{ij} \qquad (9)$$

Equation (9) lets the probabilities of different job sequences be calculated.

The model also has implications for employment stability. Equation (6) implies that the completed duration in a job has an exponential distribution and that the mean completed duration equals $1/r_{ij.}$, where $r_{ij.}$ represents the

rate of leaving job j for individual i:

$$r_{ij\cdot} = \sum_{k} r_{ijk} \qquad (10)$$

It also implies that the distribution of the number of job shifts per unit of time has a compound Poisson distribution. The exact form of this distribution cannot be written explicitly without specifying the distribution of job-shift rates.

Form B. Previous authors have proposed models of transition rates that depend either on observable characteristics of persons and jobs (see, for example, Coleman, 1964; Spilerman, 1972a; Tuma, 1976) or on unobservable characteristics (see, for example, Silcock, 1954; Blumen et al., 1955; Spilerman, 1972b). Equation (7) combines these.[12] Integrating these two types of proposals allows us to examine the effects of observed characteristics on transition rates without making the unrealistic assumption that we have specified all determinants of each rate. Furthermore, the proportional reduction in the error variance σ^2 that results from including (additional) variables provides an indicator of the fit of a model to the data.

The assumption that the random disturbance is gamma-distributed follows the suggestions of Silcock (1954) and Spilerman (1972b), neither of whom allowed observable variables to be included in the model.[13] The advantages of the gamma distribution are that it can range over all positive values (as do transition rates) and can assume a variety of shapes, from highly skewed to nearly normal. It also permits various implications of (7) to be derived. I also explored the possibility of assuming that ε_{ijk} had a log-normal distribution, but it led to mathematically intractable implications.

Selected implications of (7) are derived in the appendix. In particular, I show that in a population of matches with identical observable characteristics, the rate of every transition declines with the duration of a match. Furthermore, both the population-level rate of leaving a job and the population-level odds of shifting to one destination rather than another depend on the duration of a match. This happens even though the shift rate for any given match is a constant. By now, this is a well-known phenomenon (see, for example, McFarland, 1970).

An estimated model with a small error variance from one viewpoint may be interpreted as a model with little duration-dependence from another viewpoint. We would like to distinguish unobserved heterogeneity in a population from the true duration-dependence of an individual job-person match. In principle, certain kinds of unobserved heterogeneity can be distinguished from genuine duration-dependence. For example, unobserved characteristics of persons or jobs that affect each transition rate in the same way could be detected (in theory) by allowing the ε_{ijk}'s to covary for successive jobs of person i and for successive occupants of job j. This strategy, successfully used in linear variance-components models, is extremely difficult to implement in the case of models of transition rates, even if the necessary data were available. Consequently, we are left with some degree of ambiguity in interpreting estimated error variances. The discussion and presentation of the results in Section IV below largely ignores this problem, but readers should keep it in mind.

Estimation

Coefficients of variables are estimated by the method of maximum likelihood, which gives asymptotically unbiassed, minimum variance estimators under very weak regularity conditions on a probability distribution function (Dhrymes, 1970). The general form of the likelihood when event-history data are available is (see Tuma et al., in press):

$$\mathcal{L} = \prod_{i=1}^{N} \prod_{m=1}^{\infty} \prod_{j=1}^{n} \{[G_j(d_{imj}|Z_{ijk})]^{v_{i,m-1,j}} \cdot [r_{ijk}(d_{imj}|Z_{ijk})]^{w_{im}v_{i,m-1,j}v_{imk}} \quad (11)$$

where the total number of individuals i is N; m denotes the number of an event; j is the origin (or state left); n is the total number of origins (or states) in the system; d_{imj} is the duration that individual i spends in origin j when he entered j on his m^{th} event; $Z_{ijk} = \{z_{ijkq}\}$ is a vector of Q exogenous variables describing i, j and k; w_{im} is a dummy variable that equals unity if individual i's m^{th} event is observed; v_{imj} is a dummy variable that equals unity if individual i's m^{th} event consists of a transition to state j; K denotes the total number of destinations being considered; $G_j(\cdot)$ gives the probability of surviving in state j until d_{imj}; and $r_{ijk}(\cdot)$ is the transition rate from j to k for i after duration d_{imj}.

As indicated earlier, the form of $G_j(\cdot)$ and $r_{ijk}(\cdot)$ depend on the model assumed to describe the process of shifting jobs. These depend, in turn, on the argument being tested.

The variables in this equation are obtained from the data, as described

in Table 1. Duration in Job j and Job Left correspond to d_{imj} and w_{im}, respectively. Z_{ijk} stands for the various indicators of rewards and resources. Kind of Job Shift is used to create the set of dummy variables $\{v_{imk}\}$.

Note that Table 1 does not mention m, the number of the event (or job held). This is because the models considered in this paper assume m is irrelevant to the job-shifting process, and not because this is intrinsic to the likelihood equation.

It is worth reviewing briefly some advantages of maximum likelihood estimation. In particular, this method lets us use censored observations on the completed duration of respondents in jobs. For the jobs that respondents held at the interview, we know a starting date but not an ending date. So we can calculate duration as of the interview, but not the completed duration, which is censored by the sample design. Deleting such observations can seriously bias estimates of transition rates (Sørensen, 1977b; Tuma and Hannan, in press). Maximum likelihood estimation deals with this situation and usually provides estimates with desirable properties, even when samples are medium in size and the proportion of censored observations is high. In this paper the number of job-person matches is large (4008), and the proportion of censored observations is small (0.141). Therefore, censoring should have a negligible impact on the findings reported below.

Maximum likelihood estimation also has advantages in terms of the tests that it allows. First, we can test the relative fit of nested models. Suppose we have a model Ω and constrain s parameters in it to take certain values (usually zero). Let us call the constrained model ω.

The likelihood ratio λ is defined as $\max(\mathcal{L}_\omega)/\max(\mathcal{L}_\Omega)$, and has the property that $-2 \ln \lambda$ is asymptotically distributed as chi-square with s degrees of freedom. We reject ω if the observed value of $-2 \ln \lambda$ exceeds the critical value of chi-square with s degrees of freedom for the significance level that we have selected.

We can also test the effect of a single variable. The inverse of the matrix of second derivatives of $\ln \mathcal{L}$ with respect to parameters in a model provides an estimate of the variance-covariance matrix of parameters. The square root of the estimated variance of a parameter gives its estimated standard error. Since maximum likelihood estimators are asymptotically normal, we can perform either an F- or t-test for a significant difference between the estimated value of a parameter and its value in the null hypothesis.

An iterative procedure must be used to find the value of parameters that maximize $\mathcal{L}$ in equation (11) for all models except IA and IIIA. For these models, the maximum likelihood estimates can be written explicitly as:

$$\hat{\alpha} = \text{(Proportion of Jobs Left)/(Mean Duration in any Job j)} \qquad (12)$$

for Model IA, and

$$\hat{\alpha}_{jk} = \frac{\text{(Proportion of Moves from any Job j to Destination k)}}{\text{(Mean Duration in any Job j)}} \qquad (13)$$

for Model IIIA.

Suppose that destinations k = 1, . . . , K are selected at random and are unrelated to the job-shift process. This means that α_{jk} is independent of k, i.e.,

$$\alpha_{jk} = \alpha/K \qquad (14)$$

Note that $\hat{\alpha}_{jk}$ in (13) just equals $\hat{\alpha}$ in (12) divided by K when the proportion of moves from any job j to destination k is $(1/K)^{th}$ of the proportion of jobs left. This is just what we expect when (14) is true.

It is important to note that the maximum of $\mathcal{L}$ depends on K even if (14) is true and every destination k is unrelated to the job-shift process. The maximum of $\mathcal{L}$ for Model Ia equals the maximum of $\mathcal{L}$ for Model IIIA multipled by K for each observed job shift. A likelihood ratio test of Model IIIA against Model IA must allow for this difference.

IV. RESULTS

In spite of ample previous evidence that employment stability is not independent of characteristics of jobs and persons (see footnote 3 above), it is useful to begin by demonstrating this. This procedure lets us begin with a simple model and introduce complexity gradually.

Table 3 reports estimates for several models of the rate of leaving a job, hereafter called the exit rate. The models referenced in Table 3 are alike in ignoring the outcome of a shift, but differ in other respects.

Model IA assumes that there is a single, constant exit rate α, which describes all job shifts of all white men. The maximum likelihood estimate of α is .429 per year from (12). This implies that for white men the average completed duration in a job is 1/.429 = 2.33 years.

Model IB assumes that the exit rate within the population has a gamma distribution but is a constant for any particular job-person match. This is just the model proposed by Silcock (1954). From Table 3 we see that the estimated average rate in the population is .709 and that the estimated error

variance in the rate is .550. Using Silcock's formula for the mean completed duration in a job (1954, p. 435), we conclude that these estimates imply an average completed duration in a job of 3.13 years. Although the mean exit rate is higher in Model IB than in IA, the average completed duration is lower for IA than for IB. This occurs because Model IB predicts that some job-person matches are extremely stable. These very stable matches raise the average completed duration more than enough to compensate for the increase in the average exit rate.

Model IA can be viewed as having the same form as Model IB except that a constraint has been imposed, namely, that the error variance is exactly zero. Thus, a likelihood ratio test comparing Models IA and IB indicates whether the exit rate of white men significantly varies. The value of chi-square for this test is 572.3 with one degree of freedom. So Model IA can be rejected at any reasonable level of significance. (The probability that chi-square with one degree of freedom exceeds 10.8 is .001).

The heterogeneity in exit rates that causes us to reject Model IA may arise from effects of attributes of job or persons. Model IIA permits the exit rate to depend on personal resources, job rewards and time in the labor force. BLM's arguments suggest the hypothesis that the exit rate decreases as rewards and resources increase, other things being equal, i.e., that the multiplier of the exit rate for a unit increase in each indicator of rewards and resources is less than 1.

The likelihood ratio test of Model IIA versus Model IA is significant at the .001 level, and the effect of each observable variable included in IIA is also significant at the .001 level. The results indicate that, as hypothesized, the exit rate is smaller for jobs with greater prestige and

higher wages. Assuming time in the labor force measures acquired resources (recall however its correlation with age and period), its effect also agrees with that hypothesized--namely, that stability rises with resources. However, effects of other resources--education and ability--are exactly the opposite of those hypothesized: the exit rate rises with these resources, when rewards are controlled.

Model IIB has the same form as Model IIA but does not constrain the variance in the exit rate within the population to be zero, as IIA does. Not surprisingly, the overall pattern of effects of variables is extremely similar to that found for IIA. However, the effect of a unit increase in each variable has a somewhat stronger effect in IIB than in IIA. The likelihood ratio test of Model IIB versus any other model referenced in Table 3 (each of which is nested within IIB) is statistically significant at the .001 level. But in spite of these impressively small significance levels, the addition of the five variables has reduced the error variance by only 13.1 percent. Thus, the improvement in fit obtained by allowing the exit rate to depend on rewards, resources and time in the labor force is modest according to customary standards.

In Section II I argued that effects of rewards and resources on the rate of a job shift depend on the destination. The models in Table 3 implicitly assume that the destination is irrelevant. People are not "pulled" from jobs by the structure of opportunities, but "pushed" at a rate that depends only on characteristics of them and their current job. This view is consistent with the picture arising from marginal productivity theory, in which job shifts reflect random disequilibrating events that are as likely to produce gains as losses.

I proposed differentiating among job shifts in terms of two dimensions:

(1) whether the expected change in rewards from a shift was positive, zero, or negative; and (2) whether the shift occurred within or out of a firm. My arguments pertained to moves among jobs within the civilian nonagricultural labor force (CNALF). However, 21.3% of the observed moves in these data were to a destination not in the CNALF (e.g., military service, agricultural jobs, unemployment lasting more than a month, etc.). Moves within and out of the CNALF must be distinguished before my arguments can be tested.

Consequently, I estimated models like those in Table 3, but distinguished moves within the CNALF from moves out of it. For shifts within the CNALF, the overall pattern of effects closely resembled those in Table 3 with a few exceptions. First, the effect of education increased from 1.030 to 1.070. Second, the effect of time in the labor force became much smaller and insignificant. Third, the percentage reduction in the error variance for IIB as opposed to IB fell to 9.2%. These differences are reasonable in view of the substantial proportion of moves out of the CNALF with either military service or extended unemployment as a destination. Both strongly attract youths, suggesting the effect of time in the labor force on the exit rate in Models IIA and IIB in Table 3 mainly results from its correlation with age.

To study effects of labor market structure on job shifts with different reward changes, we must first select a measure of the change in rewards. Simplicity makes it appealing to focus on either prestige or wage changes. Given the moderately high correlation between a job's wage rate and its prestige (0.380), this strategy might sound satisfactory, as it suggests that prestige and wage changes are also moderately correlated. But this is not the case. The prestige change has a correlation of 0.119 with the absolute

wage change and 0.069 with the percentage wage change.

Table 4 reports the joint relative frequency distribution of prestige and percentage wage changes. Look first at the rows and columns labelled "All." Each entry under this heading gives the proportion of moves within the CNALF of the type indicated. Thus, 21.6% of all moves within the CNALF led to both prestige and wage gains, while only 11.2% led to both prestige and wage losses. If each type were equally likely, every entry would be 1/9 = .111. We would not expect this value, given the marginal distributions for prestige and wage changes, which favor a gain, especially in the wage rate. In fact, cell entries do not differ a great deal from the product of the marginals, indicating the prestige and wages changes are almost independent.

In terms of testing my arguments, the more important issue is the degree of similarity between the distribution of changes in rewards for moves within and out of a firm. Table 4 also gives the joint distribution of reward changes for these types of moves. The proportion of certain types are very similar for both moves within and out of a firm: moves with both a prestige and wage gain, and moves with the same wage and either a prestige gain or a prestige loss. But there are also some very marked differences. There is a much smaller proportion of moves within a firm that involve a wage loss (.079 versus .253), a prestige loss (.160 versus .326), both a wage and prestige loss (.019 versus .145), or a gain in one reward and a loss in the other. On the other hand, there a much larger proportion of moves within a firm that involve no change in either prestige or the wage, or a wage gain with no prestige change. The rates of different types of moves within and out of a firm differ significantly at any reasonable level of

significance (chi-square = 1030.2 with 8 degrees of freedom).

The nature of these differences is consistent with the hypothesis that the conditions of employment within large firms are more inflexible than those in small firms. As discussed earlier, this assumes that moves within small firms are a very small proportion of intrafirm moves. The joint distribution of prestige and wage changes for interfirm moves is much more nearly balanced than is that for intrafirm moves. Nevertheless, there is still a disproportionate number of gains, even for moves out of a firm. This suggests that even interfirm moves provide a mechanism for people to increase their attainment. We would not expect this to occur if employment conditions are flexible.

Although the distribution of rewards changes for intra- and interfirm moves differ significantly, the effects of rewards and resources on the rate of a job shift could be the same. To examine this issue, I estimated Models IVA and IVB for the rate of a job shift for all 18 types of moves. Space limitations prevent me from reporting these results in entirety.[14] I focus on three types of reward changes for moves within and out of a firm: those with a gain in both prestige and the wage rate, those with a loss in both, and those with no change in either. Results for Model IVB appear in Table 5.

Consider the results for moves <u>out</u> of a firm. First, the rate of an upward move rises with resources and falls with rewards, while the rate of a downward move rises with rewards and falls with resources, as I hypothesized. These patterns are consistent with the view that job shifts tend to reduce the average discrepancy between actual rewards in the origin job and those expected on the basis of resources. Second, effects of education on upward and downward moves are significant at the .001 level, while the effects of

ability are only weakly significant. This supports the contention that employers rely heavily on education as a performance indicator when hiring from outside their own work force, and use ability to a much small degree. Ability may be used less than education because it is less visible or because it is a poorer indicator of performance. Third, the percentage reduction in the error variance obtained from including the five observed variables is quite high for upward interfirm moves, small for downward interfirm moves, and virtually zero for lateral interfirm moves. The first suggests that workers leaving a firm for a better job both judge their new job and are judged by their new employer in terms of these highly visible indicators. Downward interfirm moves may be less explainable because they mainly result from lay-offs induced by exogenous changes in demand for the origin firm's product rather than firings due to the characteristics of a particular job-person match. Lateral interfirm moves occur for many reasons unrelated to rewards and resources, and we would not expect them moves to depend on these variables.

Now consider the results for moves <u>within</u> a firm. First, as in the case of upward moves out of a firm, the rate of upward moves within a firm (the promotion rate) rises with resources and falls with rewards. In spite of this similarity, there are also some interesting differences. The rate of an upward move depends on ability more within a firm than out of a firm, while it depends less on education within a firm than out of a firm. This is consistent with the view that employers hiring from outside their own work force must rely on highly visible indicators of performance but that those hiring from within can rely on less visible indicators such as ability. The smaller percentage reduction in the error variance for upward moves within a firm than for upward moves out of a firm also agrees with this

interpretation. Employers hiring from within can utilize many unobserved indicators of performance as a basis for promotion, whereas those hiring from without are limited to a small number of highly visible indicators. Consequently, highly visible rewards and resources cannot be expected to explain promotion rates as well as the rate of upward interfirm moves.

Model IVB also reduces substantially the error variance of the rate of downward intrafirm moves (the demotion rate). The pattern of effects of rewards and resources on the demotion rate resembles that for the rate of downward interfirm moves, except that the former has a much smaller intercept and a negligible effect for time in the labor force. However, Model IVB does not significantly improve upon the null hypothesis of no effects of rewards and resources on the demotion rate. Insignificance probably results from the very few cases reporting a demotion. Still it means that we cannot place much confidence in the estimated effects of variables on the demotion rate.

The strong effects of rewards and resources on the rate of lateral moves within a firm surprised me. I expected these moves to be unexplainable, like lateral interfirm moves. The overall pattern of effects for lateral intrafirm moves suggests that these shifts provided employees with gains (on the average) on unobserved job characteristics, for example, prestige within the firm, working conditions, etc. This possibility cannot be tested with the available data but is worth checking on other data with more detailed information on job characteristics. It is also interesting that time in the labor force increases rather strongly the rate of lateral intrafirm moves. If these moves indeed provide gains, it appears that rewards other than prestige and the wage rate play an increasingly important role in the attainment process for older, more experienced workers.

CONCLUSIONS

In this paper I have undertaken three main tasks: (1) I have analyzed four main arguments about the way people with varying resources (e.g., education, ability) are allocated to jobs with different rewards (e.g., prestige, wages). (2) I have proposed an extension of existing methods of analyzing job shifts. (3) I have used the proposed method on data on job shifts of white males age 30-39 in 1968 to test hypotheses based on the four arguments. In discussing each of the three, I reached a number of different conclusions--far too many to summarize all of them here. I shall mention only the most important points under each.

1. Employment conditions surrounding a job may be flexible or inflexible. Flexible employment means that an employer can freely adjust a worker's wage and terminate his job; inflexible employment means that an employer is constrained (if not completely prevented) in taking either course of action. When employment is flexible, a person's expected gain from a job shift is zero, and mobility, though an interesting phenomenon, is not terribly important for understanding the distribution of rewards among persons or over one person's career. When employment is inflexible, a person's expected gain from a job shift is positive, and mobility is of fundamental importance for understanding the distribution of rewards.

2. Various explanations of labor allocation and reward distribution generate hypotheses about both employment stability and the relative frequency of different kinds of moves. These hypotheses can be translated into models of the instantaneous rate of a shift from one kind of job to another. Previous models have assumed that a shift rate depends <u>either</u> on observable variables <u>or</u> on unobservable variables. I propose combining these assumptions. In

this way we avoid the unrealistic assumption that we have perfectly specified a model of a shift rate. We can also estimate the proportion of variance in the rates within some population that is explained by the variables used to test hypotheses.

3. For white men in the United States, the proportion of job shifts accompanied by gains (in prestige and wages) exceed those accompanied by losses. This tendency is very marked for intrafirm shifts but also noticeable for interfirm shifts. This finding is consistent with the argument that employment tends to be more inflexible in large firms than in small ones, assuming that most intrafirm moves originate in large firms.

Furthermore, as hypothesized, the effect of education on the rate of upward moves is greater for interfirm moves than for intrafirm moves, while the effect of ability is smaller for interfirm moves than for intrafirm moves. On the most basic level, this indicates that the determinants of the shift rate depends on a person's social location, and not just on his characteristics.

Overall these findings imply that mobility is <u>not</u> just an interesting side issue in understanding the distribution of rewards in the United States. Job shifts may not be the only mechanism by which people increase their job rewards, but it is certainly one such mechanism, apparently an important one.

APPENDIX A

This appendix outlines implications of the assumption that the instantaneous rate of a transition from job j to destination k for some individual i, r_{ijk}, is the product of two terms: A_{ijk}, a function of observable variables describing i, j and k; and ε_{ijk}, a gamma-distributed random disturbance representing pure noise (and possibly unobservable characteristics of i, j and k). Thus I assume that

$$r_{ijk} = A_{ijk}\varepsilon_{ijk} \tag{A.1}$$

where

$$E(\varepsilon_{ijk}) = 1 \tag{A.2}$$

$$Var(\varepsilon_{ijk}) = \sigma^2_{ijk} = 1/B_{ijk} \tag{A.3}$$

$$h(\varepsilon_{ijk}) = \frac{B_{ijk}^{B_{ijk}}}{\Gamma(B_{ijk})} \varepsilon_{ijk}^{B_{ijk}-1} e^{-B_{ijk}\varepsilon_{ijk}} \tag{A.4}$$

for all i, j and k.

In this paper I also assume that $B_{ijk} = B_{jk}$ for any particular j and k and for all i, and that

$$A_{ijk} = e^{\Theta_{jk0} + \sum_{q=1}^{Q} \Theta_{jkq} z_{ijkq}} = \alpha_{jk0} \cdot \prod_{q=1}^{Q} (\alpha_{jkq})^{z_{ijkq}} \tag{A.5}$$

where z_{ijkq} is one of Q variables describing i, j and k; and $\alpha_{jkq} = e^{\Theta_{jkq}}$ is one of Q+1 parameters to be estimated. Though values of variables may vary from one job-person match to another, parameters are assumed to be invariant within the population studied. The steps that follow do not

depend on the functional form relating A_{ijk} to exogenous variables or on the assumption that B_{ijk} equals B_{jk} and does not depend on variables. Consequently, the ensuing derivations are expressed in terms of A_{ijk} and B_{jk} to retain generality.

Together (A.1) and (A.4) imply that each transition rate r_{ijk} is gamma-distributed with probability density:

$$g(r_{ijk}) = h(\varepsilon_{ijk}) \frac{d\varepsilon_{ijk}}{dr_{ijk}} \tag{A.6}$$

$$g(r_{ijk}) = \frac{(B_{jk}/A_{ijk})^{B_{jk}}}{\Gamma(B_{jk})} r_{ijk}^{(B_{jk}-1)} e^{-B_{jk}r_{ijk}/A_{ijk}} \tag{A.7}$$

The above expression implies that the rate r_{ijk} has the following mean and variance:

$$E(r_{ijk}) = A_{ijk} \tag{A.8}$$

$$Var(r_{ijk}) = A_{ijk}^2\sigma_{jk}^2 = A_{ijk}^2/B_{jk} \tag{A.9}$$

Since transition rates are unobservable variables, (A.7) cannot be used to estimate A_{ijk} and B_{jk} directly. However, (A.7) can be used to deduce the probability density of various observable variables. Given data on one of these observable variables, the method of maximum likelihood can then be used to estimate A_{ijk} and B_{jk}.

In this paper I suppose that event history data are available. This type of data supplies information on the number, timing, and sequence of events. Thus there are observations on the duration between successive events (i.e., the duration in job j, d_j) and the kind of job k entered

after job j is left. Below I sketch the derivation of the probability density of d_j and the expected value of r_{ijk} in the population.

Because r_{ijk} is a constant for any i, j and k by the assumption in (A.1), the duration d_j between entering and leaving job j has an exponential distribution with the probability density given by:

$$f_j(d_j|\{r_{ijk}\}) = \left[\sum_{k=1}^{K} r_{ijk}\right] e^{-d_j \sum_{k=1}^{K} r_{ijk}} \qquad (A.10)$$

Note that (A. 10) is a conditional density; the distribution of d_j depends on the set of unobservable variables $\{r_{ijk}\}$. But to estimate parameters from data, we need the unconditional density of d_j. This can be obtained by multiplying the conditional density in (A. 10) with the joint probability density of the set of transition rates r_{ijk} and then integrating over all possible values of each r_{ijk} (i.e., from 0 to ∞):

$$f_j(d_j) = \underbrace{\int_0^\infty \cdots \int_0^\infty}_{K} f_j(d_j|\{r_{ijk}\})\, g(\{r_{ijk}\})\, \underbrace{dr_{ij1}\cdots dr_{ijK}}_{K} \qquad (A.11)$$

where K is the total number of destinations. Equation (A.10) provides the first term within the integral. Note that the second term is the joint distribution of transition rates, which has not yet been specified. (Equation (A.7) gives only the marginal probability density of each transition rate.)

Though it is reasonable to assume that in general transition rates to different destinations are statistically dependent, i.e., errors are correlated across destinations, the succeeding steps in the derivation are enormously simplified by assuming statistical independence. Then the

joint probability density of the set of transition rates is just the product of the marginal probability densities:

$$g(\{r_{ijk}\}) = \prod_{k=1}^{K} g(r_{ijk}) \qquad (A.12)$$

where (A.7) gives $g(r_{ijk})$.

Now we need only substitute (A.10) and (A.12) into equation (A.11) and then integrate in order to obtain the unconditional probability density of d_j. After a number of tedious but straightforward steps, we finally obtain:

$$f_j(d_j) = \left[\sum_{k=1}^{K} \frac{A_{ijk}B_{jk}}{A_{ijk}d_j+B_{jk}}\right] \prod_{k=1}^{K} \left(\frac{B_{jk}}{A_{ijk}d_j+B_{jk}}\right)^{B_{jk}} \qquad (A.13)$$

Let $G_j(d_j)$ represent the survivor function, defined as $1 - F_j(d_j)$, where $F_j(d_j)$ is the cumulative probability distribution of d_j. Since the probability density is the derivative of the cumulative distribution function, i.e., $f(u) = dF(u)/du$, (A.13) implies that the survivor function is:

$$G_j(d_j) = \prod_{k=1}^{K} \left(\frac{B_{jk}}{A_{ijk}d_j+B_{jk}}\right)^{B_{jk}} \qquad (A.14)$$

Moreover, the unconditional rate of leaving job j after duration d_j is related to the probability density function and the survivor function as follows:

$$f_j(d_j)/G_j(d_j) = r_{ij}(d_j) = \sum_{k=1}^{K} r_{ijk}(d_j) \qquad (A.15)$$

So, (A.13) through (A.15) imply that the population-level rate of leaving j is:

$$r_{ij}(d_j) = \sum_{k=1}^{K} \frac{A_{ijk}B_{jk}}{A_{ijk}d_j + B_{jk}} \qquad (A.16)$$

which suggests that

$$r_{ijk}(d_j) = \frac{A_{ijk}B_{jk}}{A_{ijk}d_j + B_{jk}} \qquad (A.17)$$

To prove (A.17) requires that we proceed through a series of steps like those above. We begin by multiplying both sides of (A.10) by $r_{ijk}/(\sum_{k=1}^{K} r_{ijk})$, which gives:

$$r_{ijk} \cdot G_j(d_j|\{r_{ijk}\}) = r_{ijk}\, e^{-d_j \sum_{k=1}^{K} r_{ijk}} \qquad (A.18)$$

Equation (A.18) refers to a particular individual in the population, but what we want is its expected value in the population. To find this, we multiply (A.18) by the joint probability density of the set of transition rates $\{r_{ijk}\}$ as given by (A.12), and then integrate over all possible values of each transition rate, analogous to (A.11). We obtain:

$$r_{ijk}(d_j)G_j(d_j) = \frac{A_{ijk}B_{jk}}{A_{ijk}d_j + B_{jk}} \prod_{k=1}^{K} \left(\frac{B_{jk}}{A_{ijk}d_j + B_{jk}}\right)^{B_{jk}} \qquad (A.19)$$

Dividing both sides of (A.19) by $G_j(d_j)$ as given by (A.14) yields (A.17) exactly.

FOOTNOTES

[1]For a useful discussion of ways of defining labor market structure, see Althauser and Kalleberg, 1977.

[2]Sørensen and Kalleberg (1977) and Sørensen and Tuma (1978) distinguish between "open" and "closed" employment. In the former the employer is free to terminate an employee's job; in the latter he is not. These authors implicitly assume that wage rigidity accompanies closed employment and that wage flexibility is present when employment is open. But this need not be the case. I have used a different terminology to emphasize that both rigid wages and closed employment are necessary for the conclusions reached about inflexible employment in subsequent discussion.

[3]For evidence of the first, see Blau and Duncan, 1967. For evidence of the second, see Mincer, 1974. Byrne (1975) and Hayghe (1975) give evidence of the third. Numerous other sources could be cited in each instance.

[4]One additional assumption is that buyers and sellers maximize utility: Employers maximize profits, and workers maximize utility that depends on leisure, money, and occasionally other nonpecuniary values.

[5]Another aspect deals with investments specific to the match, e.g., job-specific training. They argue that stability of the match increases with specific investments. See also Becker, 1964; Tuma, 1976. This argument also suggests the rate of a shift declines as duration increases. Sørensen and Tuma (1978) and Tuma (1976) have estimated models in which the rate of a job shift declines as duration increases. This possibility is ignored in this paper.

[6]For example, the organization of the construction industry leads to a much higher rate of lateral moves in that industry than in most others.

[7]The lay-off rate may be high in certain industries, and lay-offs lead to a high proportion of downward moves. However, lay-offs are not triggered by characteristics of a particular job-person match but by a slackened demand for the firm's product.

[8]Jobs at the highest rungs of a large firm bear many similarities to jobs in small firms. In this regard, it is interesting that popular folklore says that top executives are as likely to suffer a demotion (even if only a slight one) as a promotion.

[9]Leigh (1976) has compared gains of blacks and whites who shift industries and who remain in the same industry. For both races he finds that movers tend to gain more than stayers. Unfortunately, he does not report effects of variables indicating the resources of workers, although they were included in his analysis.

[10]March and March (1977) have developed a model of intrafirm shifts based on the assumption that performance records on the job are the criterion used by employers in allocating employees to different jobs.

[11]Time-independence is an admittedly unrealistic assumption. It is easy to formulate arguments why shift rates depend on age, duration, and historical period. But it is beyond the scope of this paper to encompass these arguments or to include these variables.

[12]Michael C. Keeley first suggested this to me.

[13]Both Silcock and Spilerman assume that only the rate of leaving a job has a random disturbance.

[14]There are other reasons for not reporting these. In particular, it is difficult to know whether a move involving a gain in one reward and a loss in the other should be considered a net gain, loss, or no change. Because of this, it is difficult to know whether the results for these shifts support a hypothesis or not.

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Table 1. Variables Used in the Analysis: Definitions, Means, Standard Deviations, Minimum, and Maximum.

Variable	Definition	Mean	S.D.	Min.	Max.
Time in Labor Force (T_{ij})	Years from labor force entry to start of job j. By definition, labor force entry begins with the start of full-time employment lasting 18 months or more.	7.40	5.60	0	25.50
Ability	Number of correct answers on 10-item word recognition test. Adjusted for missing values on single items.	6.11	1.90	1	10
Education	Years of completed schooling at start of job j.	12.02	2.81	6	20
Prestige for Job j	Siegel (1971) prestige score for job j.	35.91	14.00	12.20	82.40
Wage Rate for Job j	Estimated wage in dollars per hour at start of job j. Calculated as: $\frac{12(\text{Monthly earnings in \$})}{52(\text{Average hours per week})}$	2.14	1.09	.04	13.49
Duration in Job j (d_j)	Last date in job j - first date in job j (based on reported year and month for each date).	2.00	2.58	.083	21.33
Job Left (Dummy Variable)	1 if job j left before interview; 0 if job j still held at interview	.86	.35	0	1
Kind of Job Shift (Nominal Variable)	0 if no job shift or if destination k is not in the CNALF; E(3P+W) otherwise, where: E = 2 if different employers in j and k 1 if same employer in j and k P = 2 if prestige of k > prestige of j 1 if prestige of k = prestige of j 0 if prestige of k < prestige of j W = 3 if (wage rate of k)/(wage rate of j) > 1.05 2 if .95 ≤ (wage rate of k)/(wage rate of j) ≤ 1.05 1 if (wage rate of k)/(wage rate of j) < .95			0	18

Table 2. Models of the Rate of a Job Shift.

Model Number	Postulated Form
I	$r_{ij\cdot} = \alpha$
II	$r_{ij\cdot} = \alpha_{j\cdot 0}(\alpha_{j\cdot X})^{X_i}(\alpha_{j\cdot Y})^{Y_j}(\alpha_{j\cdot T})^{T_{ij}}$
III	$r_{ijk} = \alpha_{jk}$
IV	$r_{ijk} = \alpha_{jk0}(\alpha_{jkX})^{X_i}(\alpha_{jkY})^{Y_j}(\alpha_{jkT})^{T_{ij}}$

Note: An individual is denoted by i, the job left by j, and the job entered by k. The rate of i leaving job j is denoted by $r_{ij\cdot}$ and the rate of a shift from j to k by i by r_{ijk}. X_i represents i's personal resources (education, etc.); Y_j represents rewards of job j (prestige, etc.); T_{ij} represents the length of time that individual i has been in the labor force at the start of job j. The α's are parameters to be estimated.

Table 3. Estimates for Models of a Job Shift (Unstandardized Multipliers of the Rate of a Job Shift).

	MODEL			
	IA	IB	IIA	IIB
Intercept	.429	.709	.631	1.288
Time in Labor Force (years)			.986***	.979***
Ability			1.067***	1.074***
Education (years)			1.036***	1.030***
Prestige			.975***	.972***
Wage Rate ($/hr.)			.925***	.887***
Error Variance		.550		.478
% Reduction in Error Variance				13.1
Chi-square for model versus:				
Model IA		572.3***	403.2***	960.1***
Degrees of freedom		1	5	6
Model IB				557.0***
Degrees of freedom				1
Model IIA				387.8***
Degrees of freedom				5
N = 4008 job-person matches				

Note: For definitions of models, see text. For definitions of variables, see Table 1. Time is measured in years, so rates are expressed in years^{-1}.

*$.05 \geq p > .01$ **$.01 \geq p > .001$ ***$.001 \geq p$

Table 4. Joint Relative Frequency Distribution of Changes in the Occupational Prestige and the Wage Rate of White Men Who Move Among Jobs in the Civilian Nonagricultural Labor Force by Type of Move (Within and Out of a Firm)

		PRESTIGE GAIN			PRESTIGE SAME			PRESTIGE LOSS			
		All	Out	In	All	Out	In	All	Out	In	Marginals
WAGE GAIN	All	.216			.163			.117			.496
	Out		.215			.124			.131		.470
	In			.216			.270			.079	.565
WAGE SAME	All	.061			.108			.053			.222
	Out		.057			.069			.050		.176
	In			.073			.222			.062	.357
WAGE LOSS	All	.123			.047			.112			.282
	Out		.154			.054			.145		.253
	In			.030			.030			.019	.079
Marginals		.400	.426	.319	.318	.247	.522	.282	.326	.160	1.000

Number of Intrafirm Moves	699	(25.8%)
Number of Interfirm Moves	2011	(74.2%)
Total Number of Moves within the CNALF	2710	(100.0%)
Total Number of Moves out of the CNALF	732	
Total Number with No Move Observed	566	
Total Number of Job-Person Matches	4008	

Table 5. Estimates for Models III and IV for Upward, Lateral, and Downward Job Shifts Within and Out of a Firm (Unstandardized Multipliers of the Rate)

	DIRECTION OF MOVE					
	Upward		Lateral		Downward	
	Out	In	Out	In	Out	In
Estimate for Model IIIA	.054	.019	.017	.019	.036	.0016
Estimates for Model IVB						
Intercept	.279	.033	.037	.001	.200	.002
Time in Labor Force (years)	1.025*	1.016	1.039	1.052*	.924***	1.006
Ability	1.097*	1.226**	.856†	1.319***	.929	.980
Education (years)	1.203***	1.091†	1.020	1.275***	.848***	.828
Prestige	.919***	.936***	1.002	.958***	1.029***	1.036
Wage Rate ($/hr.)	.460***	.797†	1.095	.791†	1.221*	1.397
Error Variance	2.01	4.46	18.09	12.16	3.52	9.73
% Reduction in Error Variance (IVB vs. IIIB)	67.5	46.3	0.4	44.8	14.1	52.7
Chi-square for Model IVB vs.						
Model IIIA (df = 6)	479.7***	87.3***	41.9***	122.0***	73.0***	5.6
Model IIIB (df = 5)	372.4***	71.9***	9.3†	74.2***	48.4***	5.5
Model IVA (df = 1)	55.8***	10.4**	33.8***	41.4***	30.9***	.02
N = 4008 job-person matches						

Note: For definitions of models, see text. For definitions of variables, see Table 1. Time is measured in years, so rates are expressed in years^{-1}.

† $.10 \geq p \geq .05$ * $.05 \geq p > .01$ ** $.01 \geq p > .001$ *** $.001 \geq p$